(2)

NPS-54-88-012

NAVAL POSTGRADUATE SCHOOL

Monterey, California

THE EFFECTS OF SEA PAY ON REENLISTMENTS AND VOLUNTARY EXTENSIONS

Loren M. Solnick

November 1988

Prepared for: Economics Analysis Section, MIlitary Compensation Branch
OP-134E
Navy Annex
Washington D.C. 20370

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NPS-54-88-012	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION Economic Analysis Section, Military Compensation Branch (OP-134E)
6c. ADDRESS (City, State, and ZIP Code) Monterey, CA 93943	7b. ADDRESS (City, State, and ZIP Code) Navy Annex Washington, DC 20370
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Naval Postgraduate School 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER 02MN, Direct Funds
8c. ADDRESS (City, State, and ZIP Code) Monterey California 93943	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
The Effects of Sea Pay on Reenlistments and Voluntary Extensions

12. PERSONAL AUTHOR(S)
Loren M. Solnick

13a. TYPE OF REPORT	13b TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Final Report	FROM _____ TO _____	December 1, 1988	35

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Sea Pay, Reenlistment

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The report assesses the state of knowledge regarding the effects of sea pay on reenlistments and extensions of enlisted personnel. The major theoretical and empirical studies are reviewed, and their limitations noted. A research agenda is proposed based on gaps in the state of knowledge and the needs of Navy manpower planners. The report concludes that models using individual level data, incorporating information from the Annual Survey of Officers and Enlisted Personnel, would produce better estimates. The author recommends that future research also consider the effects of sea pay on the quality of enlisted personnel who reenlist.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Loren M. Solnick	22b. TELEPHONE (Include Area Code) 408, 646-2249 / 22c. OFFICE SYMBOL 54Sb

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

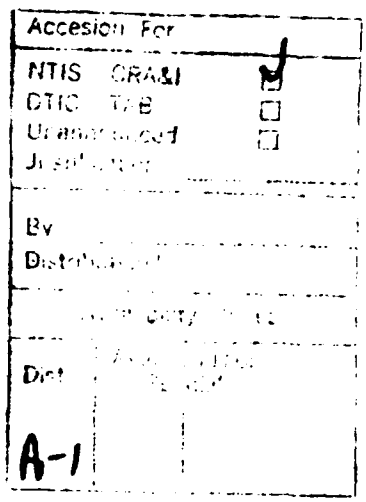
U.S. Government Printing Office: 1988—606-243

The Effects of Sea Pay on Reenlistments and Voluntary Extensions

by

Loren M. Solnick *

Department of Administrative Sciences
Naval Postgraduate School
Monterey, CA 93943



November 1988

*The author would like to thank Steve Cylke and Tim Cooke for their help in conducting this study, and their inciteful comments on a preliminary draft.

I. Introduction

This report is an assessment of the state of knowledge regarding the effects of sea pay on reenlistments and extensions of enlisted personnel. These effects are important to Navy manpower planners because they impact on the enlisted experience distribution and on recruitment needs, both of which have major implications for the cost of maintaining a force of any given size. The report goes beyond merely reviewing the pertinent research, as this has been done recently by Radtke (1984) and Cooke (1985). It attempts to (1) spell out what specific information will be most useful to Navy manpower planners; (2) evaluate the data and models used in conducting past research; and (3) make recommendations regarding the direction of future research.

Sea duty is an issue that cannot be divorced from any study of the impacts of sea pay. A fundamental reason for sea pay is to compensate personnel for the separation and discomfort of sea duty. In general, the more time a sailor spends on sea duty, the less likely he is to reenlist. Thus, sea pay helps to offset the negative retention effects of sea duty. Most of the empirical (and some of the theoretical) studies of sea pay also consider the impact of sea duty. Unfortunately, as a result of both data limitations and modeling choices, discussed below, the estimated effects of sea duty on reenlistments and extensions are inconsistent and not very statistically reliable.

The report will also make recommendations for better accounting for the role of sea duty. Perhaps the most important reason for improved measurement and modeling of sea duty is that estimates of the effects of sea pay may be biased without accurate control for sea duty.

In order to establish a framework for the review and analysis that follows, the major issues that have emerged in determining the effects of sea pay on reenlistments and extensions are summarized here. The fundamental question is to what extent reenlistment and extension decisions are influenced by the level of sea pay. The issues enumerated here address the problem of estimating models whose parameters can provide valid inferences about that influence.

(1) The interaction between reenlistments and extensions: Since sea pay affects both, they should be considered jointly. Moreover, the models should allow sea pay to have different effects on each choice. However, most statistical models that do so require that the choices be independent. If some enlisted men extend for short periods in order to subsequently receive an anticipated larger reenlistment bonus, then those statistical models will not produce unbiased estimates of the desired parameters.

(2) The effect of sea pay on sea duty needs to be considered independently of its effects on reenlistments or extensions. The main purpose of sea pay is to encourage sailors to spend more time at sea by compensating them for the unpleasant aspects of

sea duty. The importance of this issue lies in the criticality of manning the fleet.

(3) Self-selection into sea-intensive rating: The major empirical studies have analyzed reenlistment behavior by occupational categories, which vary in the average amount of time spent on sea duty. If enlisted men are self-selecting into the more sea duty intensive occupations because of their personal taste for sea duty, attempts to infer the effect of differences in sea duty on reenlistments will be biased. Therefore, estimates of the effect on reenlistments of sea pay differences needed to compensate for sea duty differences will also be biased.

(4) Modeling of the impact of sea pay: Most studies have not explicitly related sea pay to reenlistment or extension behavior; they assume that pay elasticities are the same irrespective of the source of the pay change. Although this approach is based on accepted economic theory, it ignores the tie between sea pay and sea duty. The one study (Radtke, 1984) that did explicitly estimate separate sea pay effects found them to differ from the effects of other pay, and also to have a perverse impact on retention in some models.

(5) Aggregate vs. individual data: Most of the major studies aggregate individual data into cells defined by length of service, occupational specialty (ratings) and year of reenlistment decision. This aggregation process necessitates using cell averages for other explanatory variables (pay, sea

duty, demographic factors, etc.), which may bias the resulting parameter estimates. Cooke (1986) found substantial variations in sea duty within ratings, and that the sea pay differential can vary with demographic factors like marital status, because of loss of certain shore allowances when sailors are on sea duty. These within cells variances exacerbate the aggregation bias problem.

(6) Data limitations: The complex manner in which sea pay is calculated, and the difference between sea duty for sea/shore rotation and for sea pay, increase the difficulty of accurately measuring sea pay for any individual or group.

(7) Quality of reenlistments/extension: The literature has recognized the need to have rating-specific estimates of sea pay and sea duty effects, but the quality of those persons has not been considered. The continually increasing complexity of jobs enlisted men must perform underscores the need for high quality sailors. However, no studies to date have considered whether variations in sea pay or sea duty have impacts on retention that vary with education level and/or mental group. One might speculate that the less able men, with less attractive civilian alternatives, may be most responsive to sea pay incentives. Thus, a policy that yielded adequate endstrength figures might not satisfy Navy manpower needs in terms of ability to perform the required tasks.

These issues provide the basic framework for reviewing the literature on sea pay and sea duty. Clearly they are derived

from studying that literature, and serve to guide future researchers toward improved analyses which will better inform Navy manpower planners.

The report is organized as follows: the second section contains a critical review of the empirical research on sea pay; the third section identifies the gaps in our knowledge, and the fourth section proposes a research agenda to fill those gaps.

II. Review of Literature

This section reviews the empirical studies of the retention effects of sea pay. A brief review of the theoretical studies of sea pay is also presented. The emphasis throughout is on the limitations of the studies, rather than a comprehensive review of their findings. This emphasis is not based on a desire to be critical *per se*, but derives from the goal of identifying weaknesses so that future research can be improved. Moreover, as noted above, Cooke (1985) has recently done an extensive review of the effects of sea pay and sea duty on retention. Some sections below draw on that review, and the interested reader is referred to that report (or the original works) for further details.

The most recent theoretical studies of sea pay are by Kleinman (1983) and Clay-Mendez (1983). Both employ an optimization approach. Kleinman asks how can the Navy most economically achieve (1) an increase in sea duty holding constant total manpower requirements or (2) and increase in total man-years holding the percent of time on sea duty constant? Kleinman

argues that an increase in reenlistment bonuses will increase total man-years more than a rise in sea pay since the latter requires additional sea duty, which has an offsetting negative effect on reenlistments. However, increasing sea pay will be more effective in increasing sea duty. These results lead Kleinman to conclude that to increase total man-years (sea duty constant) reenlistment bonuses should be increased but sea pay decreased, since the additional reenlistments will necessarily provide more man-years of sea duty. He also concludes that to increase sea duty with constant total man-years the Navy should raise sea pay but lower reenlistment bonuses, since the extra sea pay will increase both reenlistments and extensions.

Clay-Mendez uses a more formal approach, deriving her results from a model based on utility maximization by individual enlisted men. The Navy sets sea pay and reenlistment bonuses so as to minimize costs, and individuals choose whether to reenlist or not. If sailors have homogeneous tastes for sea duty, a desired reenlistment rate is attained at least cost using bonuses alone, since raising sea pay increases extensions at the expense of reenlistments. Clay-Mendez also finds that in general, if tastes for sea duty vary, a constant sea/shore ratio is inefficient since it fails to take advantage of those persons with a preference for sea duty (i.e., those less averse to sea duty would spend more time at sea for the same level of sea pay). An exception to this result obtains if the distribution of tastes for sea duty is such that the average percent of time sailors

wish to spend at sea exceeds the percent needed by the Navy. This is clearly counter-factual, however.

These studies are interesting for two reasons. They provide a benchmark for evaluating the empirical studies that attempt to provide quantitative estimates of the effects predicted by the theoretical analyses. In addition, they raise some interesting issues: What balance between extensions and reenlistments is optimal for the Navy? What influences enlisted men's taste for sea duty?

Next we turn to four econometric studies of retention. Three of the studies, by Warner and Goldberg (1982 and 1983) and Goldberg and Warner (1983), do not directly estimate sea pay *effects on retention*, but those effects can be inferred from their estimates of the sensitivity of reenlistments (and extensions in one study) to *changes in regular pay*. The fourth study, by Radtke (1984), tests whether sea pay has different effects than other forms of pay. All four studies use a common methodology, which is described first. Then the major findings of the studies are summarized.

The general approach of the four studies cited above is to divide the large number of very specific occupational ratings of enlisted personnel into a smaller number of occupational groups. The ratings in each group are similar in terms of training, job requirements and working conditions. The empirical model used in all of the four studies is the now well-known annualized cost of leaving (ACOL) model. The cost of leaving is "the difference

between the present value of the income stream staying n more years and then leaving and the income stream from leaving immediately" (Goldberg and Warner, 1983, p. 9). The individual stays in the Navy if his ACOL is greater than the present value of his net preference for civilian life, i.e., the present value of the income stream associated with staying in the Navy exceeds the person's distaste for military life. By assuming that preferences for civilian versus military life are normally distributed, a non-linear relationship can be derived between ACOL and the probability of reenlisting (or extending). This relationship is estimated by either probit analysis or logistic regression. The estimated models also include other variables which may influence retention behavior (e.g., marital status, civilian unemployment rate, expected amount of sea duty during next period of service).

The seminal study by Warner and Goldberg (1981) finds statistically significant impacts of ACOL on first-term reenlistments in 15 of 16 occupational groups. In addition, the authors find a negative correlation between the weighted ACOL estimates and the percent of careerists in sea duty in those occupations, implying that sea duty reduces the elasticity of the supply curves of enlisted personnel (as represented by the ACOL coefficients). However, Cooke (1985) notes that the correlation between the unweighted pay elasticities and the sea duty of careerists is much smaller than the weighted correlation, and significant only at the .20 level. Thus, this finding is not

very convincing. Warner and Goldberg estimated another (cross-sectional) model, that directly estimated the effects of sea duty. The results of this model indicate a strong negative relationship between expected future sea duty and reenlistments.

Although highly regarded, and widely used and cited, there are some shortcomings to this study. Perhaps most important is the specification of the basic probit equation. Besides ACOL, the only other independent variables are marital status and the civilian unemployment rate, which varies only over time and not by occupational group or rating within each group. There are surely other factors that may influence the reenlistment decision. There is an extensive literature on civilian quit behavior that identifies many job-related factors that affect quitting: job satisfaction, performance ratings, promotion rates, and fringe benefits (see Arnold and Feldman (1982), Dreher (1982), Keller (1984), Mitchell (1982), and Solnick (1988)). If any of these omitted factors are correlated with both reenlistments and ACOL, the estimates of the effect of ACOL on reenlisting will be biased, the extent and direction of the bias depending on the size and sign of the correlations between the omitted variables and both reenlistment and ACOL.

The cross-sectional analysis of Warner and Goldberg has a better specification since it includes a variable for expected future sea duty. Although this variable is consistent with the ACOL variable, in the sense that they both focus on the expected future values of the variables, the approach ignores the

potentially large impact of past sea duty on the reenlistment decision. It is plausible that past sea duty may significantly affect reenlistment behavior by influencing each persons's taste for military versus civilian life. The omission of this and other job satisfaction factors have an unknown but possibly large impact on the estimates of the effect of ACOL.

Another deficiency of the Warner and Goldberg study is the measurement of civilian pay, one of the two components of ACOL. Civilian earnings are measured using the earnings of enlisted personnel who left the Navy. Since this calculation considers only those who chose to leave the Navy, their earnings are subject to selection bias. Clearly those who leave, cet. par. are those who on average find civilian life more attractive than those who remain in the Navy. This can result from either a stronger distaste for military life, or better civilian earnings, or some combination of both. Thus, Warner and Goldberg's measure of civilian earnings will tend to overstate those earnings, and therefore underestimate ACOL, for enlisted personnel who reenlist. This suggests an upward bias in the estimated relationship between reenlisting and ACOL: Warner and Goldberg's estimates may be larger than the true parameters.

Warner and Goldberg (1984) extended their study of reenlistment decisions to analyze length of reenlistment. The major determinant of length of reenlistment, given that the decision to reenlist has already been made, is the selective reenlistment bonus (SRB). Since this study has no direct bearing

on the reenlistment decisions, and does not provide explicit estimates of the effects of sea pay or sea duty on reenlistment length, its major results are noted briefly. Warner and Goldberg found that length of reenlistment was positively related to the average annual bonus, the payment of a lump sum bonus, and a higher civilian unemployment rate. They also found that when Congressionally mandated bonus limits were binding, the average length of reenlistment was reduced.

More relevant to this evaluation is the Goldberg and Warner (1983) study of extensions and reenlistments. A reenlistment is defined as the signing of a contract for at least three years of additional service, whereas an extension is the signing of a contract for less than three years. A utility maximization model of the joint decision to reenlist, extend or leave the Navy is used to derive a multinomial logit model. Since the data are grouped, not individual (i.e., reenlistment rates and extension rates are calculated for cells as described above), multiple regression analysis can be used to estimate two log-odds equations for reenlistment vs. leaving and extension vs. leaving. The primary independent variable is ACOL, which differs between reenlistments and extensions because those who reenlist receive a bonus whereas those who extend do not. The equations also include variables to control for the civilian unemployment rate, expected future sea duty, length of service, marital status, race, educational level, mental group and expiration of contracts

in the late months of fiscal years 1977 through 1980.[1] The equations were estimated for nine occupational groups, and for both first-and second-term reenlist/extend decisions.

The ACOL variable has the expected positive effect on first-term reenlistments and extensions, the estimates being significant in eight of nine groups.[2] The results for the expected sea duty variable are mixed. With respect to reenlistments, it is significantly negative in five of nine groups, but positive for three groups (significant for one of them). A similar pattern was also found in the extension equations, although there were fewer significant coefficients.

The second-term results are similar for the ACOL variable, but even less consistent for expected sea duty. The extension equations produced three significantly positive estimates, but only two estimates that were significantly negative. The second-term reenlistment results were similarly mixed, but with fewer significant coefficients. In general, these inconsistent results for expected future sea duty are both puzzling and disturbing. There are several possible explanations: enlisted personnel self-select into ratings, and therefore are not necessarily adversely affected by the prospect of future sea duty; the

---

[1]This variable was included to capture the effects of individuals who in those years could execute short extensions into the next fiscal years in order to subsequently receive larger SRB's (see Goldberg and Warner, pp. 35-36).

[2]The estimation process constrains the ACOL coefficient to be the same for both extensions and reenlistments. This constraint is tested by Radtke (1984), discussed below.

variable used is a poor proxy for the effect of sea duty on reenlistment/extension decisions; the sea pay differential offsets partially the negative effects of sea duty (that differential is not accounted for in the ACOL variable).

In addition to the problems just noted with regard to the sea duty variable, there are other difficulties with the study. Unlike the first study of reenlistments discussed above (Warner and Goldberg, 1981), this study uses cell averages for all the variables, including the reenlistment and extension rates.[3] The results are thus subject to aggregation bias of indeterminant amount and direction. Also, the effects of sea pay can only be inferred indirectly through the coefficients of the ACOL variable. In fact, Goldberg and Warner use the ACOL coefficients only to evaluate the impact of an increase in reenlistment bonuses or regular military compensation, and don't calculate the effects of changes in sea pay.

Radtke's (1984) thesis extends the Goldberg and Warner study in two ways. First, it includes more recent data, which covers a period of substantial increases in sea pay. Second, the study attempts to estimate directly the effects of sea pay on reenlistments and extensions. Radtke thus tests the implicit assumption of Goldberg and Warner that pay elasticities are the same regardless of the pay source (i.e., regular military compensation, reenlistment bonuses or sea pay). Radtke also

---

[3]The 1982 study used individual data within 16 occupational groups.

estimates several additional specifications of the two log-odds equations. Goldberg and Warner assume that the effect of ACOL is the same on reenlistments and extensions (i.e., the coefficients of ACOL in the two equations are constrained to be equal). Radtke's models allow the different pay sources to have different effects on reenlistments and extensions, and in some cases the same pay source to have different effects on reenlistments and on extensions.

In one model, reenlistment bonuses are constrained to have an impact on extensions that is equal to, but opposite in sign from its effect on reenlistments. The exact specification of these models is given in Radtke, and summarized by Cooke (1985). With respect to the data used, other variables included in the model, and estimation procedure (logistic regression), Radtke's work parallels that of Goldberg and Warner.

With four variants of a two-equation model Radtke's work is not easily summarized. The first model, which is the same as the Goldberg and Warner specification, has results similar to the earlier study. The pay coefficients are positive and significant for each of the nine occupational groups, and for equations that pool the nine groups (not estimated by Goldberg and Warner). The coefficients for expected sea duty are mostly negative, the major exception being the health occupations group.

Radtke's second model estimates separate effects for sea pay, although both the ACOL and sea pay variables are constrained to have equal effects on reenlistments and extensions. The

common effect of sea pay on reenlistments and extensions is positive for eight of the nine groups, and significant in five of them. It is also highly significant for the pooled model. As Radtke notes (pp. 50-51), some sea pay coefficients are larger, and some smaller than the coefficients for "other pay." For some groups the sea pay coefficient is three to four times larger than the other pay coefficient, but the difference for the pooled group is small and not statistically significant (Cooke, 1985).

Radtke's third model allows sea pay and reenlistment bonuses to have separate effects on reenlistments and on extensions, although other pay is still constrained to have the same effect on both choices. With five different pay variables in the two equations, the results of this model are difficult to summarize. The "other pay" coefficient is no longer positive for every group, and is significantly negative in one case. For the pooled sample, however, it remains significantly positive. Much of the impact of the pay variable has been picked up by the sea pay and bonus variables.

The effect of sea pay on reenlistments is <u>negative</u> for the pooled group, and for six of the nine occupational groups. However, the effect of sea pay is positive on extensions in every case, and significant in all but two of them. Radtke does not discuss the negative sea pay/reenlistment estimates, but they are contrary to expectations. A possible explanation is that the use of so many pay variables has caused multi-collinearity, which in extreme cases can cause sign reversals among the highly

correlated variables. Since these models are estimated over a pooled cross-section/time series sample, this possibility is greater if sea pay and bonus increases are correlated over time. This question needs further analysis since the results are contrary to theoretical predictions and to common sense.

In this third model, Radtke finds expected sea duty has a generally negative effect on both reenlistments and extensions, as expected. The reenlistment bonus variable has the expected positive effects on reenlistments and negative effects on extensions. To summarize, Radtke's third model, while appealing since it estimates separate sea pay effects, produces perverse results with respect to reenlistments for that crucial variable.

Cooke (1985, p. 28) notes the strong negative impact of bonuses on extensions in Radtke's third model suggests that "reenlistments and extensions are closer substitutes than reenlistments and leaving." This may have led Radtke to his fourth model, which constrains bonuses to have an effect on extensions that is equal to, but opposite in sign from, its effect on reenlistments. In this version, sea pay is again allowed to have an effect separate from the "other pay" and bonus variables, but both it and "other pay" are constrained to have equal effects on reenlistments and extensions. The results for this model show sea pay having a consistently positive common effect on reenlistments and extensions. These results are consistent with Radtke's model 2 results. However, one cannot help but wonder, in light of the model 3 results, to what extent

these effects are an artifact of the constrained estimation procedure. The positive effects of sea pay on extensions found in model 3 were generally much larger than the comparable negative effects on reenlistments. The common sea pay effects of models 2 and 4 may therefore be masking the more complex pattern of model 3. A separate study by Goldberg (1985) tested the assumptions that pay effects should be constrained to be equal in both equations, and that the reenlist/extend/leave the Navy choices are truly independent. His results suggest that those assumptions are not valid, adding support to the need for a more thorough investigation of these issues. The implication that raising sea pay may increase extensions at the expense of reenlistments has far-reaching implications for Navy manpower planning.

There are several other studies that relate to sea pay and either reenlistments or extensions. Since these studies, described below, do not provide original estimates of sea pay effects, they are discussed here in less detail. However, some of the ideas presented in these studies are useful in assessing the state of knowledge of sea pay effects.

Zulli and Shelor (1985) attempted to study the effects of sea pay on voluntary extensions of sea duty. This approach can provide a useful addition to the Navy's ability to plan for effective manpower utilization. Since manning ships is a critical manpower problem, extensions of sea duty is a potential alternative to increasing general reenlistments and extensions.

It may also be an economical alternative, since enlisted men are retained in positions for which they are trained, and there are no relocation costs.

Unfortunately, the Zulli-Shelor study was never completed. It provided a detailed analysis of Navy assignment policy, essential to modeling sea duty extension decisions, and outlined the date sources and models to be estimated. However, absence of continued funding prevented compilation of the data and estimation of model parameters. It is interesting to note that the empirical model specified by Zulli and Shelor included a variable to capture the negative effects on extensions of past sea duty. Their proxy was an average of underway days by quarter, and they note that absence of this variable could result in bias to the coefficient of the sea pay variable. This is analogous to the argument made above that past sea duty may affect reenlistment and extension decisions, and should be included in the models in addition to (or perhaps in lieu of) expected future sea duty.

A study by Goldberg (1982) compares the incremental cost per retained person of different types of pay increases. Reenlistment bonuses, pay increases across the board and targeted by pay grade, and sea pay increases were considered. The per person first-term retention cost was highest for sea pay. The sea pay calculations were based on the results of an earlier study by Warner and Simon (1979), and have several shortcomings. Cooke (1985) notes that in the Goldberg study "sea pay is assumed

to be paid to everyone for all time at sea and that only future sea pay is assumed to affect retention" (p.31). Cooke also notes that the possible effects of past sea pay and sea duty on the reenlistment/extensions/leave decision are not tested. The methodological and data limitations of this study render its cost estimates suspect, and thus possibly misleading.

A study by Frankel and Butler (1984) compares the cost of two ways of increasing sea duty: creating rotation billets (shore billets needed to provide some shore time) and increasing sea pay. Since each way has a cost, the authors ask under what conditions will each by advantageous (i.e. the lower cost way of obtaining additional sea duty). Their answer is to calculate break-even elasticities, which provide ranges for which sea pay will be more or less effective than rotation billets. These break-even values can be compared to estimated sea pay supply elasticities, when good estimates of those elasticities are available. Frankel and Butler find that the break-even sea pay elasticities are quite low, generally below unity, and conclude that even if enlisted personnel "are relatively unresponsive to sea pay increases, increases in sea tour length elicited by increased sea pay would be more than compensated by shore billet savings." (p. 3).

The method used by Frankel and Butler to calculate the break even elasticities utilizes the Force Analysis Simulation Model (FASM), a computer based simulation model developed for the Navy by the SAG Corporation. This model is run under varying

assumptions about sea/shore rotation rates, and the resulting cost savings[4] are used to calculate the desired elasticities. Although an evaluation of the FASM model is beyond the scope of this study (and it has been revised subsequent to its use by Frankel and Butler), it is possible to assess its validity for the present study. As used by Frankel and Butler the FASM model has several shortcomings. Most importantly, Frankel and Butler suppress changes in retention rates when they change the sea/shore rotation rate. This is a clearly unrealistic assumption, since we know that in general a higher sea/shore ratio will decrease retention rates. (Goldberg and Warner, and Radtke). In fact the authors' method of calculating the break-even elasticities is fatally flawed because it assumes that the retention rates are unaffected by sea/shore rotation, although the trade-off between the two is the theoretical basis for the study. The authors' calculations also include the assumption "that sea pay elasticities are the same among all paygrade /LOS cells ..." (LOS cells are length of service cells). The impact of this assumption is unknown, but the authors do not attempt a sensitivity analysis which might suggest how relaxing that assumption would affect their estimates.

A recent study by Cooke and Garvey (1986) attempts to estimate the retention effects of changes in sea pay proposed by Congress for FY 1987. Very briefly, the revised sea pay tables

---

[4]The model provides least-cost force estimates for any set of assumptions.

would increase sea pay for grades E5 through E7 with five or more years of cumulative sea duty, but reduce sea pay for grades E4 through E9 with less than five years cumulative sea duty. Cooke and Garvey used a rating-specific version of CNA's ACOL simulation model (Cymrot and Garvey, 1986) to estimate the retention effects of the sea pay changes for four rating groups (sea intensive; mission critical, sea intensive; mission critical, some sea billets; mission critical, no sea billets). They find that the first two groups, which are sea intensive, are most strongly affected by the increased sea pay. This result derives primarily from the fact that these groups necessarily contain a higher percentage of personnel who are eligible for the increased sea pay. (Note that the retention-pay elasticities of the four groups do not differ very substantially - see table 3, p. 7). This study is an interesting exercise since it provides an opportunity to test the ACOL model. It would be instructive to compare actual retention data to that predicted by the model.

Cooke (1986) has conducted a study of sea duty and sea pay that is best viewed as preliminary to improved estimation of retention effects. There are two major findings that are relevant to developing improved retention models. First, Cooke finds that the variance in sea duty within ratings is as large as its variance across ratings. Second, he finds that for some personnel, loss of shore allowances substantially offsets sea pay, so that total compensation is not very different at sea than in a shore billet.

The importance for retention modeling of the latter finding is obvious: models must fully and accurately measure the net pay change associated with sea duty to accurately estimate its effect. With respect to the first finding, Cooke concludes that future research should "address the relationship of variation in sea duty within ratings to retention." (p.30). These findings, along with some of the limitations of previous studies noted above, form the bases for the research agenda proposed in the following section.

III. State of Knowledge

This section identifies the gaps in our knowledge of the retention effects of sea pay and sea duty. To do that, we begin with an outline of what Navy manpower planners should want to know. A comparison with what is known from existing research identifies the knowledge gaps.

The Navy should want to know:

(1) The effect of sea pay on voluntary extensions of sea duty.

(2) The impacts of sea pay and sea duty on reenlistment and extension probabilities, separately for

- (a) First and second term personnel
- (b) Sea intensive and mission critical ratings
- (c) Mental groups
- (d) Length of reenlistment

(3) The effect of extending on subsequent reenlistment probabilities.[5]

Where are we now? The literature reviewed above provides preliminary estimates of reenlistment and extension probabilities for first and second term stay/leave decisions for various ratings groups. Those estimates suffer from a variety of statistical and data-related shortcomings, and can therefore only be considered tentative, useful with proper reservations, until replaced by better figures. There are currently no studies of qualitative retention effects i.e., whether high mental group personnel are more or less responsive to sea pay and sea duty variations than low mental group persons. This is an overlooked but an important part of assessing the Navy's ability to perform its mission. There are also no studies of how extending effects the subsequent probability of reenlisting.[6] This issue is important because it will impact on the experience distribution of the enlisted force. It is also necessary to study this interaction to learn whether some extensions are merely mechanisms to take advantage of anticipated higher subsequent reenlistment bonuses.

---

[5]This list is certainly not exhaustive, but includes the major factors that manpower planners need to calculate endstrength and readiness effects of changes in sea pay and/or sea duty.

[6]Cymrot (1987) has conducted a study that showed that Marine Corps extenders were more likely to reenlist than those who did not extend.

IV. Research Agenda

A research agenda for studying the impacts on retention of sea pay and sea duty should aim to satisfy two general goals: improving existing estimates that are limited by data quality or modeling deficiencies; and identifying neglected areas of research. This section addresses each of those goals.

A major conclusion of this study is that future research should utilize individual data, not cell averages. The original Warmer and Goldberg (1982) study used individual data, although divided into 16 occupational groups. Subsequent studies (e.g. Goldberg and Warmer, and Radtke) used aggregated data, apparently to permit use of regression techniques that could adjust for data deficiencies associated with pooling time-series and cross-section data. The problems of aggregation bias, large within groups variances in critical variables (e.g. sea duty) and the difficulty of modeling inter-temporal behavior, such as extensions and subsequent reenlistments, all argue against this approach. Moreover, the difference in pay associated with sea duty varies among individuals in the same cell, as a result of marital status. There have been many recent advances in the application of multivariate techniques to discrete choices using panel data (pooled cross-section and time-series).[7] The potential gains appear to outweigh the additional effort and computing cost of these more complex procedures.

---

[7]See the recent survey article by Maddala (1987).

A second major conclusion is that subsequent research should incorporate some of the wealth of data contained in the Annual Survey of Officers and Enlisted Personnel. The survey contains much information on satisfaction with military life, some of which have been shown to be significantly related to intentions to remain in the Navy (Marsh, 1988).[8] In addition, the influence of past sea duty should also be included in future studies. These data can be obtained from the Enlisted Master File. The perverse results for future sea duty obtained by Radtke may be in past due to self-selection, or other factors noted above. Control for past sea duty, which varies substantially within ratings (Cooke, 1986), might correctly identify the true effects of sea duty on retention.

A third major conclusion is that studies of the retention effects of sea pay and sea duty should be broadened to consider the quality of personnel who reenlist, extend, or leave the Navy.[9] The importance of the quality of retained personnel is underscored by two factors: the growing complexity of weapons systems and the use of computer controls will continue to increase the need for enlisted personnel capable of being trained to operate these complex systems; budgetary constrains in the

---

[8]Thesis research being conducted at the Naval Postgraduate School by LT Anne-Marie Rearden, under my supervision, shows that there are significant effects of satisfaction variables and reenlistment intentions on actual reenlistments.

[9]Such research may also need to consider differential attrition rates prior to reenlistment decisions.

future are likely to increase the emphasis on quality of personnel, since their quantity may well be limited. The use of models based on individual data will facilitate separate estimates for each quality group.

The fourth major conclusion is that the relationship between extending and subsequent reenlistment should be studied. This relationship has two important implications: if some personnel are extending in order to subsequently receive higher reenlistment bonuses a redesign of the bonuses system may be warranted; if extenders are more likely to reenlist (after allowing for SRB's), then the possible negative consequences of an extension compared to a reenlistment is largely mitigated. However, this issue then raises the question "Why do enlisted personnel extend rather than reenlist, if they eventually reenlist anyway?" Although one might speculate that some individuals are simply not ready at the first decision point to make the longer term commitment, a thorough study of the factors that influence that choice seems desirable.

The first, second and fourth conclusions all relate in different ways to how analysts should model the reenlistment/extension/leave the Navy decision, and then best estimate the model parameters. This issue is fundamental to future research on the effects of sea pay, and is thus discussed here in more depth. Although model development and testing are major undertakings, not feasible under the limitations of this study, some suggestions in this area are appropriate.

First, the impact of sea pay on reenlistments must be estimated separately from the effects of other types of pay. Since sea pay is always associated with certain undesirable job characteristics, its impact on reenlistments should differ from that of other pays unless the offsetting negative utility of those job features can be perfectly measured and controlled for. Future research should perhaps begin by recognizing that the primary impact of sea pay is a sea duty vis-a-vis shore duty: it is a compensating differential intended to make sea duty relatively less unattractive. Further, the secondary effect of sea pay on reenlistments or extensions needs to also consider the impact of the associated sea duty, as in Radtke's study.

Second, more thought should be given as to the possible decision processes of enlisted personnel. The Goldberg-Warner and Radtke models that assume a three-way choice among independent alternatives is only one way to approach the problem. There are three other possible choice models:[10] (1) a stay/leave decision is made first, then a reenlistment/extension decision for stayers; (2) a reenlist/not reenlistment decision followed by an extend/leave decision for non-reenlisters; (3) an extend/not extend decision, then a reenlist/leave decision for non-extenders.

Each of these alternatives poses different modeling and estimation problems. However, statistical models and software are now available to test those alternatives against the three-

---

[10]I thank Tim Cooke for suggesting these alternatives.

way choice model, using individual data. Goldberg (1985) attempted some tests of these nested logit models using grouped data estimates.

Third, the self-selection issue needs explicit treatment. If selection into sea-intensive ratings is correlated with sensitivity of reenlistment behavior to pay changes, then estimates of the effects of sea pay on both retention and sea duty will be biased. Although the statistical procedures to adjust for selection bias are now well-known, and soft-ware widely available, the correct modeling of this complex process has not yet been done. Moreover, it may be quite difficult to simultaneously adjust for selection bias and test for correct specification of the decision process, as described above.

In summary, this study has recommended several ways to improve past retention research, and identified several related areas that have not been studied at all. There is not much that is original here, as many of the shortcomings of previous studies have been noted by others, especially Tim Cooke. The paper does, however, bring together ideas that were scattered among a number of different papers. The idea of studying the quality of retained personnel is new, but may find few advocates among Navy manpower planners, since research on sea pay and retention is currently not a high priority. Nonetheless, this agenda can serve as the basis of new retention research if those priorities should change in the future.

References

Arnold, H. and D. Feldman, "A Multivariate Analysis of the Determinants of Job Turnover," Journal of Applied Psychology, Vol. 67, 1982, pp. 350-360.

Clay-Mendez, Deborah, "Sand Castles on the Sea Shore: A Theoretical Analysis of Sea Pay and Sea-Shore Rotation," Center for Naval Analyses, 83-0504, April 1983.

Cooke, Timothy, "Sea Pay, Sea Duty, and Retention: A Survey," Center for Naval Analyses, CRM85-36, June 1985.

_____, "Sea Duty and Sea Pay: An Exploratory Analysis," Center for Naval Analyses, CRM86-75, April 1986.

Cooke, Timothy and K. Garvey, "Retention Effects of the FY1987 Sea-Pay Proposal," Center for Naval Analyses, CRM86-66, April 1986.

Cymrot, Donald, "Extensions and Subsequent Reenlistment in the U.S. Marine Corps," Center for Naval Analyses, CRM87-91, June 1987.

Cymrot, Donald and K. Garvey, "Rating-Specific ACOL: Modifications to the All-Navy Model," Center for Naval Analyses, CRM86-54, March 1986.

Dreher, G. F., "The Role of Performance in the Turnover Process," Academy of Management Journal, Vol. 25, 1982, pp. 137-147.

Frankel, Oliver and R. Butler, "The Trade-Off Between Shore Rotation Billets and Sea Pay," The Assessment Group, mimeo, August 1984.

Goldberg, Matthew, "Cost Effectiveness of Alternative Pay Increases," Center for Naval Analyses, Memorandum 81-1947, January 1982.

_____, "Logit Specification Tests Using Grouped Data," Center for Naval Analyses, Working paper 85-0016, January, 1985.

Goldberg, Matthew and J. Warner, "Determinants of Navy Reenlistment and Extension Rates," Center for Naval Analyses, CRC476, December 1982.

Keller, R. T., "The Role of Performance and Absenteeism in the Prediction of Turnover," Academy of Management Journal, Vol. 27, 1984, pp. 176-183.

Kleinman, Samuel, "Sea Pay and Reenlistment Bonuses: A Framework for Analysis," Center for Naval Analyses, Memorandum 83-0644, April 1983.

Maddala, G. S., "Limited Dependent Variable Models Using Panel Data," Journal of Human Resources, Vol. 22, 1987, pp. 307-338.

Marsh, Robert, "Factors Influencing Retention Intentions in the U.S. Navy," U.S. Naval Academy, mimeo, March 1988.

Mitchell, Olivia, "Fringe Benefits and Labor Mobility," The Journal of Human Resources, Vol. 17, 1982, pp. 286-298.

Radtke, Gary M., "The Effects of Sea Pay on Labor Supply Decisions in the U.S. Navy," unpublished Master's thesis, Clemson University, 1984.

Solnick, Loren M., "Promotions, Pay, Performance Ratings and Quits," Eastern Economic Journal, Vol. 114, Jan-March 1988, pp. 51-62.

Warner, John and M. Goldberg, "The Influence of Non-Pecuniary Factors on Labor Supply," Center for Naval Analyses, Professional Paper 337, December 1981.

_____, "The Bonus Ceiling and the Length of Navy Reenlistment Contracts," Center for Naval Analyses, Memorandum 83-1378.10, March 1984.

Zulli, David and C. Shelor, "Sea Duty Compensation and Voluntary Extensions of Sea Duty," The Assessment Group, mimeo, February 1985.

Distribution List

Agency	No. of copies
Defense Technical Information Center Cameron Station Alexandria, VA 22314	2
Dudley Knox Library, Code 0142 Naval Postgraduate School Monterey, CA 93943	2
Office of Research Administration Code 012 Naval Postgraduate School Monterey, CA 93943	1
Library, Center for Naval Analyses 4401 Ford Avenue Alexandria, VA 22302-0268	1
Department of Administrative Sciences Library Code 54 Naval Postgraduate School Monterey, CA 93943	1
Steve Cylke (OP-134E) Economics Analysis Section, Military Compensation Branch, Navy Annex Washington, DC 20370	2
Loren M. Solnick Code 54Sb Naval Postgraduate School Monterey, CA 93943	10
Chief of Naval Research 800 N. Quincy St. Arlington, VA 22217-5000	2
Timothy Cooke Center for Naval Analyses 4401 Ford Ave., P.O. Box 16268 Alexandria, VA 22302-0268	2
Lee Mairs SAG Corporation 900 S. Washington St., Suite 109 Falls Church, VA 22046	1